Implementing production planning processes in health care – a case study of a surgery clinic

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Abstract

This paper deals with the problems of production planning and control within healthcare, and the immature state of this area within healthcare. The paper reports on the first phase of an action research project within a surgery department at a Swedish public hospital group, and reports the problem identification process together with the first implementations of improved processes in relation to PPC. The paper concludes that there is a large discrepancy between the treatments of the area in research, focusing detailed methods, e.g. within scheduling, and the need of the healthcare organizations, due to the immature state. The question posed in this paper is whether more simple models, implemented step-wise, together with a focus on the planning process and the understanding of it, is able to show any early results in terms of, primarily, patient waiting times. The result from the case clearly indicate that this is possible, the quantitative data showing considerable decrease in waiting times both to outpatient appointments and to elective surgery treatment.

Keywords: Production Planning and Control, Implementation, Healthcare.

1. Introduction

Healthcare systems in many countries share a number of challenges for the future. From an economic perspective, both health expenditure per capita and as percentage of GDP has increased over the last 50 years. For the OECD countries, health spending accounted for 4 % in 1960 and had increased to 9.6 % in 2009 (OECD, 2011). Many studies point at the problem of an ageing population requiring higher volume of care and treatment (e.g. Zhang et al., 2010), and to that increased costs of new medications and equipment add considerably to healthcare systems being under economic pressure (e.g. Meropol, 2009). A second challenge common to health care systems in many countries is the access of care, in terms of long waiting times. Long waiting times causes problems of several types, e.g. lower health-related quality of life (Derrett et al., 1999), societal costs due to work absenteeism (Hoel and Sæther, 2003), patient dissatisfaction (Hiidenhovi, 2002), and possibly higher costs of managing the waiting list (Siciliani et al., 2009).

Several approaches and means are applied in order to improve the systems in terms of costs and availability. Some are aimed at national levels, e.g. changes in order to increase competition among healthcare providers (e.g. Brekke et al., 2008), governmental incentives as for examples in Sweden, Canada, and UK, while others are at the individual healthcare unit level. In the later category, lean production initiatives have gained great attention during recent years (e.g. Papadopoulus, 2011). Numerous lean developments have been implemented, and the subject has grown in interest within

operations management research (e.g. LaGanga, 2011). Similarly, quality management and improvement approaches, like TQM and Six sigma, have been applied in healthcare, starting much earlier then the lean initiatives (Nicolay, 2012). Generally, concepts and approaches emanating from the manufacturing industry has grown in interest within healthcare, mainly in order to improve performance in terms of costs and availability. The reason why quality approaches gained early interest was probably because these approaches could be successfully applied to issues of traditionally great concern within healthcare, e.g. patient safety and effectiveness of treatment methods.

Another area now growing in interest within healthcare, taking inspiration from manufacturing industry, is production planning and control (PPC). However, this development is in a much earlier stage and by far not as widespread among the healthcare systems as the quality and the lean production initiatives. However, the potential usefulness of improvements in this area is obvious. As core goals of production planning and control are to balance supply of resources to demand from the market, to allocate resources in the most effective way, and to make good use of scarce resources, the area is most promising in being effective in regard to the challenges of both costs and availability.

The predominant PPC model in manufacturing is based on the MRP II model, developed in the 60's. In turn, this was a development from the MRP model, and has now evolved into ERP system models, and later acronyms making use of more advanced methods. The basic idea of the model is a hierarchy of planning levels, where decisions taken at a higher level frame the decisions at the next lower level. At higher planning levels, the planning horizon is longer, the planning object is more aggregated, and the planning frequency is higher. Required capacity is calculated from forecasts or customer orders, and then compared to available capacity for each period within the planning horizon. This general model has proved to be effective in great many various contexts, although always being necessary to adapt to the specific conditions of an operation, in terms of type of customer demand, the product, and the production system.

Production planning and control processes, as known from manufacturing industry and briefly characterized above, is yet hardly adopted at all in healthcare. There may be several reasons to the difference in adopting PPC. First, priorities and basic values differ between the contextual environments. Instead of, basically, being profitable by offering and selling competitive products, healthcare is by tradition driven by terms like care, cure, and safety. Second, the power of the customer has traditionally been different, where healthcare customers generally have had low power. Third, the healthcare industry as a whole, including its network of service and product providers, is homogenous in this respect, e.g. meaning lack of successful models, and lack of supporting services and products in the area of PPC. Although production planning in healthcare is far from as developed as in manufacturing, research points at the usefulness and feasibility of applying a generalized hierarchical planning model of the same type as known from industrial production also in healthcare, e.g. Vissers et al. (2001), Larsson and Johansson (2007), and Iannone et al. (2011).

The conclusion from the above text is that this model is possible to apply in healthcare settings and should have great advantages over the present praxis of planning. However, in manufacturing industry, the PPC models have been developed during more than 50 years, in contrast to the immature processes in healthcare, Also, as noted above, no common planning model exists within healthcare and, consequently, the planning processes are not supported by a set of basically homogenous information and planning software products. Therefore, it is of great interest to better understand the important conditions governing the implementation of PPC systems in healthcare. As it is virtually impossible to implement and reach the manufacturing industry standard "over-night", it is of interest to study the benefits possible to gain during a step-wise implementation, starting by implementing rough and simple models. This paper discusses this issue by a single case study, describing and analysing the first two years of an improvement project at a surgery department of a Swedish hospital, focusing the aspects related to implementing a production planning and control system.

The organization of the paper is that, following this introduction, basic theory on production planning and control is presented, both in general and within healthcare. This is followed by the methodology, describing the research approach and the data gathering, where after the case is presented. The case is then discussed, partly by using the theoretical frame, before ending with conclusions.

2. Frame of reference

This section first gives a brief outline of PPC systems and presents one of several generic planning models. Thereafter, the general picture of research on PPC within the healthcare domain is presented.

The Production Planning and Control system deals with many aspects of the organization and its operations, from the strategic level to the execution of production, and includes processes, methods and tools to, for example, schedule machines and other resources, coordinate suppliers and customers, and to determine capacity levels. According to Vollmann et al. (2005), the essential task of the system is to "manage efficiently the flow of material, to manage the utilization of people and equipment, and to respond to customer requirements by utilizing the capacity of our suppliers, that of our internal facilities, and (in some cases) that of our customers to meet customer demand". Important to note is that the word "system" do not mean a computer system, but a system comprising of elements such as organization, methods, and people.

There are several generic planning models available, all having the same basic structure and basically using the same terminology, following the standard by APICS. Common to all these generic models is that they are built up in a hierarchical way. Typically, three or four planning levels are defined, corresponding to different time horizons of the planning. The different levels of the planning system are linked by outputs from the planning level above. Thereby, if looking at the planning system as a decision system, the decisions taken at a planning level is framed by the decisions taken at the next upper level, which is an important feature of the models. In accordance with the types of planning decisions taken and the time horizons, the planning objects become more aggregated at higher planning levels, and the planning period becomes longer.

One of these generic models is presented by Jonsson and Mattsson (2009), and consists of four hierarchical planning levels: Sales and operations planning, Master planning, Order planning and Shop floor planning. The basic structure of the model is presented in figure 1.

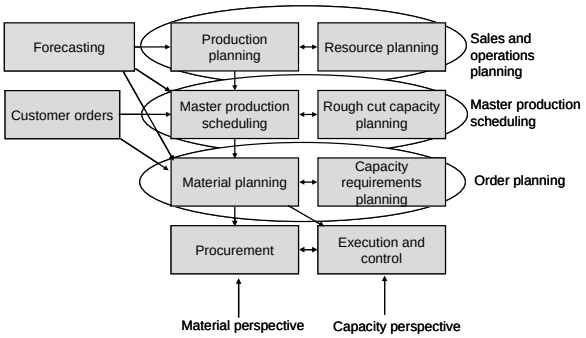

Figure 1: The generic planning model (Jonsson and Mattsson, 2009).

In this model, the forecasting process links to the planning system by providing input to the processes at the different levels. The right side of the model represents the capacity planning processes, and the left side represents the production planning at different levels of detail. An important task is to, at each planning level, match the capacity of the production system to the required capacity determined by the decided plans. In doing so, a capacity strategy is decided. The two basic strategies available are

the levelling strategy and the chase strategy. In the former case, the company strives to produce at a constant rate, whereas the chase strategy means that one tries to produce according to the demand for each planning period. Constant production and levelled schedules, both in terms of volume and mix, may increase production efficiency, but takes that uncertainty in demand can be managed (van der Krogt et al., 2010).

Several papers points at the possibilities of applying the generic hierarchical planning model known from manufacturing industry also in healthcare (e.g. Rhyne and Jupp, 1988; Vissers et al., 2001 and Larsson and Johansson, 2007). Vissers et al. (2001) address the planning environment of healthcare, including its state of production control development and the unclear concepts of products and processes, and develops a dedicated framework. Adan et al. (2011) develops a two-stage planning procedure for master planning of elective and emergency patients, using a goal programming approach where four types of required resources are considered. Belien and Demeulemeester (2007) propose a three-stage procedure for developing effective operating room (OR) schedules, also with a multi-resource perspective, using a mixed integer programming based heuristics. The three stages are: allocation of OR time to surgical specialties at strategic level, development of a master surgery schedule at tactical level and scheduling individual patients at operational level.

The two last references above are examples of what could be seen as the mainstream of research related to planning within healthcare, i.e. the use of an operations research approach. May et al. (2011) reviewed literature on surgical scheduling by structuring according to the planning horizon dealt with, and proposes topics for further research. They conclude by stating: "Over the past 55 years, a variety of standard operations research models have been proposed for use in hospital scheduling, but none appear to have had widespread impact on the actual practice of surgical scheduling". Surprisingly, a more process-oriented approach to planning is not evident in their suggestions for future research. Cardoen et al. (2010) provides a comprehensive review on operating room planning and scheduling. They conclude that better integration of the operating room downstream and upstream facilities and resources should be favoured in future research. They also found that the majority of the results and models provided in reviewed papers have been tested for applicability on real data. Still, it can be noted that very little have been disseminated and put into practice.

From above, it is relevant to put the question whether the development of advanced planning tools and methods, e.g. concerning surgery scheduling, are of any use to practice, as the planning process and the structured hierarchical approach are not in place. Larsson and Johansson (2007) states that the short-term planning process, isolated, is comparatively well developed within healthcare, compared to the upper planning levels.

3. Methodology

3.1. Research approach and case selection

The objective of the study was to better understand the conditions and potential benefits in the early stages of the implementation of a structured production planning process within healthcare operations. For that purpose, a deep single case study design was appropriate, as this gives the possibility to study a phenomenon within a complex system in which the boundary between phenomenon and context is not clear (Yin, 2003). The case organization chosen in this study was the surgery department at Skövde hospital, responsible for the operations within three out of the four hospitals within Skaraborg Hospital Group, and the case itself concerns the first two years of an improvement project, from May 2010 to May 2012. Focus of the study is on the aspects of Production Planning and Control within the improvement project. The organization and the project are further described in section four of the paper – Case description. The gathered data is analysed in two steps. First, a case description is produced, describing the problems identified and the first measures taken,

together with aggregated data on performance. Second, the results from the description are discussed by using the general planning model presented in the frame of reference section.

The case is considered appropriate as the department at the start of the improvement project exhibited characteristics judged as typical to many hospitals in Sweden, including waiting time problems and under-developed planning processes. This judgement is based on statistics from the Swedish national database concerning availability in healthcare and from the experience of the authors, having a good overview of the Swedish healthcare system and an extensive network within the sector. Also, from discussions with Western European healthcare systems and researchers, the characteristics are most likely shared with many hospitals outside Sweden. One rationale for choosing a surgical department is that such departments include the main types of operations at a hospital, i.e. outpatient clinic appointments, elective surgery, acute surgery, emergency care, and inpatient wards. Also, the problem of waiting times being considered too long is common at surgical departments, and one of the main drivers for starting the improvement project in the case organization.

Another great advantage of the case was the availability of empirical data and the comprehensive understanding of the organization and its operations, as the main author of this paper had been working as a doctor in the department for many years. Also, when starting the improvement project at the department, the main author was hired as the project leader. At the time, he was also a doctoral student within logistics, specializing in production planning and control. This means that the study is undertaken as action research, involving actors of the study object in the research. Issues in relation to this are discussed below.

3.2. Data collection

Data collection has been performed throughout the study period, including on-spot observations, interviews, secondary data in form of for example meeting minutes, and quantitative data from the information systems on waiting times, production results, staffing, etc. The multitude of data sources and the attendance of a variety of forums have permitted a deep understanding of the system, the problems, the implemented changes and the change process itself, and great possibilities of triangulation in order to increase validity of the study.

Quantitative data have been gathered from different information systems, i.e. the operation planning system Orbit, the patient administration systems APAS/KPAS, the regional database for waiting time, and from the doctors schedules. Data from the computerized systems have considered being of high validity, as the data is used at an aggregated level, covering long time periods.

The main author, hired as the project leader, has been attending many of the meetings of the improvement groups, as well as workshops and management meetings during the study, and has been in close collaboration with the management of the department and with the members of the improvement groups organized at the start of the project. In addition to the input from the improvement groups, he has also at several occasions arranged workshops, including a SWOT-analysis workshop, for all the 200 employees in the department, and arranged focus group discussions regarding production and capacity planning. Further, both semi-structured and unstructured interviews, together with “coffee break discussions” and attending management meetings, have permitted input from all different professions and functions at the department. Minutes from the improvement groups and from the managerial meetings, as well as own notes taken when observing, interviewing and collaborating with the staff, have been a source for deeper understanding of culture and attitudes towards change, which has helped during the project and in this study. Reading notes taken by group members at improvement group meetings and comparing with my own notes and understandings has been one way of trying to validate data collected. Being a action researcher and at the same time the project leader of the case project, meaning that the organization is well know to the researcher and the

researcher being well known by the organization, gives a good opportunity to access data and thereby retrieving profound knowledge about the organization and the culture within the department.

During the project and the study, the improvement groups have worked in the same structured way, i.e. identifying problems, either by the group or by input from managers or employees, then verifying the problem, brainstorming on solutions, and the implementation of solutions. Verification of problems have mainly been done through quantitative data, e.g. on the coordination of available surgery rooms and doctors allocated to the surgery theatre. The improvement group working with patient flows in the surgical wards and in the operating theatre were part of a national improvement project led by the University hospital in Uppsala and the results from this group have continuously, during the project, been presented to the authors, and spread and anchored within the department.

However, actions research having the researchers directly involved in the change process is suffering from some possible problems. When performing an insider action research study, as in this case, it is critical that the researcher handle three interlocking challenges (Coghlan and Brannick, 2005). The first challenge how to build on the insiders pre-understanding of the studied organization and the culture within it, at the same time creating distance to see things critically and enable change to happen. Second, the researcher has to manage the role duality in being a full member of the organization, and at the same time taking the role of the researcher, which demands a more detached, reflective and theoretic position. Finally, the researcher may need to handle political issues within the organization regarding the research project.

To handle the issue regarding pre-understanding we have used democratic multidisciplinary settings (Gustavsen, 1985) to gather information about problems concerning the planning processes. Inquiring all different categories of staff involved in the processes has been a way to obtain profound knowledge of these processes and problems related to them from several points of views. The intended role of the insider researcher, at the same time the project leader of the improvement project, has been the one of a facilitator and not a manager, with a clear objective to participate in all meetings in a neutral way.

The role duality conflict stated above has been less of a problem in this study due to the fact that author was employed to only work as a project leader in the department during this period. Not being a full member of the staff in the department might lead to less knowledge about some issues regarding the improvement project but on the other hand gathered in the democratic multidisciplinary settings.

To handle political issues during the study, the authors have collaborated closely with the managerial team in several ways. At the start of the project, a lot of effort was put into the selection of participants in the improvement groups, and in defining the mandate of these groups and the change process it self. In this matter the role of the project leader has been a “political entrepreneur” (Buchanan and Badham, 1999).

4. Case description

This section presents the case and is divided in three sub sections. First, the general characteristic of the case organization and its operations is presented. Second, the organization of the improvement project is described, and third; the measures taken within the change process are presented, together with figures on the performance development of.

4.1. General characteristics

The surgery department studied is providing specialist care for 185 000 inhabitants and is part of Skaraborgs Hospital Group, consisting of four public hospitals. The department is responsible for providing elective services in three of the four hospitals within the hospital group, and emergency general surgery at the largest of them (Skövde). All three hospitals provide outpatient clinic

appointments, and two of them (Falköping and Skövde) provide day care surgery. The fourth hospital (Lidköping) runs a separate surgery department.

The department has about 200 employees, including approximately 30 medical doctors, working in four wards, the outpatient appointment clinics, the operating theatres, and in the emergency room. For the two latter, only medical doctors are engaged, while the rest of the personnel in these operations belong to the separate departments of anaesthesia and emergency, respectively. This means, typically, that doctors share their time between a ward, the surgery theatre, and the outpatient clinic. The rest of the personnel at the surgery department mainly work at one of the units within the department.

Table 1: Structure of the operations at the three hospitals served by the department.

Hospital	Outpatient clinic appointments	Day care surgery	Inpatient care (4 wards)	Inpatient surgery	Emergency surgery
Mariestad	x				
Falköping	x	x			
Skövde	x	x	x	x	x

The medical staff is organized in four teams: upper gastrointestinal surgery; lower gastrointestinal surgery; vascular surgery; and breast, endocrine, children and cosmetic surgery. Each team is responsible for certain diagnostic groups, some of which are very team specific and can only be managed by a few doctors, whereas other diagnostic groups can be taken care of by most of the doctors in the department. The department performs about 3300 surgical procedures and 9500 outpatient clinic appointments each year. The department is also involved in educational programs for nursing students, medical students and doctors internship and residency.

4.2. The department improvement project

As addressed in the introduction part of this paper the department was facing problems regarding availability to most of its operations. For example, the waiting time to the outpatient appointment clinic, from referral to seeing the doctor, varied from 100 to 120 days between May 2009 and May 2010. Other problems faced by the department were perceived work environment issues, e.g. high level of stress, low knowledge concerning improvement processes, no arena for employees to involve in improvement work, and low awareness of the process as a whole.

Due to the general problem regarding availability in the Swedish healthcare system several initiatives have been taken. Already in 1992 the government and the Federation of Swedish councils agreed on the first Swedish Healthcare Guarantee in an attempt to reduce the waiting times. Since then, there have been several agreements concerning specific diagnostic groups. The latest agreement, from November 2005, stipulates that all patients in need of specialist care should get an appointment in the outpatient clinic within 90 days, and treatment within 90 days after decision taken. For some urgent diagnoses the timeframe is shorter, e.g. 14 days for suspected cancer. In 2010 the National Healthcare Guarantee was turned into a law (SFS 2010:243) and hereby regulating the availability. At the same time the government and the Federation of Swedish councils made a new agreement, "The waiting time billion" adding economic incentives to the healthcare system. Councils fulfilling the more ambitious goal of appointments and treatments with 60 days were awarded extra funding. This is an attempt to make the councils and the care providers to regard the availability issues seriously and aim for better results then the law defines. Regionally, based on an assessment study of the production planning processes in the hospitals of the region, made by Ernst &Young in 2010, the Regional Council of Västra Götaland emphasised the importance of an improved production planning process, which resulted in the launching of an action programme.

In the spring of 2010 the head of department took the initiative to start an improvement and development project. He had started at this position in 2009, after being a medical doctor at the department for 16 years, meaning he was well aware of the culture, the organization, and the and issues regarding availability and underdeveloped planning processes. To run and facilitate the project, one of the medical doctors was engaged as project leader for about 40 % of full time. In addition, a few people from the central development office have supported the project by, e.g., gathering data from the administrative systems and to some extent also involved in the improvement groups as method support.

To verify, identify root causes and to find possible solutions to the issues mentioned above, the head of department and the project leader decided to establish an organization of improvement groups at the different organizational units, i.e. wards and outpatient clinics, and to establish one central group with representatives from all other groups in an attempt to build a network for learning within the department.

Another goal with this organization was to minimise the risk of sub optimizing parts of the processes when trying to optimize others. All groups were set up as democratic multidisciplinary groups (Gustavsen, 1985) with method support, mainly from the project leader. A lot of effort was put into recruiting of the group members, with a clear goal to select a few champions, i.e. passionated and enthusiastic employees with high impact on the organisation, to increase the chances of success. Also, one groups - "Better flow in the operating theatre" - has been involved in a national project and that group was set up in a different fashion with staff from both the surgical department and from the operating theatre including all different categories of employees.

No intentions to introduce concepts like TQM, Lean or six Sigma where stated from the management or project group, but to introduce tools and methods when needed for each group in their work of defining problems and root causes. Neither was the implementation of planning tools or systems a stated focus of the project. Instead, the intended goals of the project were to decrease patient waiting times, to start a process of continuous improvement, and to improve the perceived working environment.

The improvement groups started one by one by having monthly meetings during the autumn of 2010, and have continued since then. The groups applied a structured approach for problem identification, development of process charts, proposing solutions, anchoring the proposals by spreading them to the staff in each ward and among the doctors, and to give everyone the opportunity to comment. To inspire and to get as many employees as possible involved, the department has arranged seminar and workshop days for all the staff, where the improvement groups have presented their experiences and proposals. Lectures on improvement and quality work and SWOT-analyses have been other topics on the agenda for these days.

4.3. Implementations and measures taken within the project

This sub section describes the work done by two of the improvement groups, i.e. the group working with the wards and elective surgery – "Better flow" - and the "Outpatient clinic improvement group", and their focus on production planning and control issues.

The wards and elective surgery – "Better flow"

The operating theatre is shared between many departments at the hospital and the surgery department is allotted a certain number of hours in the form of certain operation rooms certain days of the week. Until the beginning of 2010 the allotted capacity in the operating theatre has been very static without reallocating capacity between different departments. The capacity allocated to the surgery department is, in turn, shared between the four teams in the department. At the start of this study the department was allocated four operating rooms Monday to Thursday, except only three rooms in the afternoon on Tuesdays. On Fridays, the department was allocated three operating rooms until noon. Due to

personnel reduction in the operating theatre and due to the fact that other departments have shown increased demand of time in the operating theatre, due to increased waiting lines, the number of operating room hours allocated to the department of surgery has decreased stepwise and is today nine hours less per week compared to the situation in the beginning of 2010.

The number of beds in the two wards used by three of the teams is fixed, but flexible between the three teams. Historically, these wards have suffered from a high workload with overcrowding and too few beds to meet the needs from patients undergoing elective surgery, emergency patients and palliative patients with their special needs.

In an attempt to level out the workload in the wards, the improvement group analysed how many patients that were admitted to the wards for elective surgery each day, and detected a great variation. The number of patients admitted varied between zero and twelve per day, which caused problems regarding available beds at the ward and over-utilisation of personnel. To handle this issue they changed admission days for the different diagnoses, i.e. teams, to level out the patient flow, and thereby the required bed capacity. Another effect of this change was that most of the complicated surgery could be done in the beginning of the week. Thereby, complications can be handled during the weekdays by ordinary staff, if necessary, instead of during the weekends when fewer persons are working, and sometimes doctors on call lacking the desired expertise required for complicated cases.

A known issue, picked up by the improvement group was that the operation coordinators, responsible for matching patients from the waiting list to available operation slots and doctors, did not have a clear job description and were lacking the mandate to schedule the doctors for full days in the operating theatre. Clarifying that each doctor scheduled to work in the operating theatre is available to perform surgery that whole day has solved this problem. Also, each doctor´s competence in performing different procedures was clarified in an attempt to make it easier for the coordinators to find the right doctor for each surgical procedure.

Another issue known at the start of the project, confirmed by the improvement group, was the great variation between days regarding number of doctors scheduled in the operating theatre. This varied between two and eight from one day to another, whereas the surgical department was allocated two to four operating rooms per day. Historically, no concern has been taken to match these two capacities, which is crucial in order to make good use of the capacity and, in this case, create a levelled flow. To solve this problem a new procedure was introduced, where the doctors' schedules and days allocated to perform surgery were matched with the numbers of operating rooms allocated to the department. The proposed doctors´ schedule is sent for review by the coordinators who have to answer the question if they consider the number of doctors in the operating theatre to be too few, too many, or balanced. If anything but balanced, action will be taken to reallocate capacity, i.e. doctors, within the team, other teams or even other departments.

This improvement group was part of a national project concerning availability to surgery and patient flow through the ward and operating theatre. One task assigned to this improvement group was to create production plans and measure production outcome in the day care surgery and visualize this in predesigned diagrams in an attempt to measure the outcome from other improvement efforts performed within this project. These production plans together with production results were then presented for all doctors in the department once a month at staff meetings. This, in turn, led to that the manager has continued to show production results regarding surgical procedures, and later also production results from the outpatient clinic, on a monthly basis for all the doctors in the department to make them aware of the department's performance.

The outpatient clinic

In the outpatient clinic the staff, except the doctors, and the rooms allocated for patient appointments are fixed to the same amount every day of the week, only to be reduced during holidays.

Due to the fact that scheduling doctors for on call duties, to perform surgery and to manage the wards do have higher priority, within the department of surgery, than scheduling doctors for appointments in the outpatient clinic, the number of appointments performed has been based on available capacity, i.e. doctors scheduled to work in the clinic, and not the actual demand from patients. Historically, there has been a great variation in the number of doctors working in the clinic each day, generating problems of both under-utilization and over-utilisation of the staff in the outpatient clinic. This poor matching of the different capacities, i.e. nurses, doctors and examination rooms has contributed to availability issues, i.e. long waiting times.

In an attempt to address the actual patient demand and to find a way to level the flow through the clinic, the improvement group in the outpatient clinic gathered historical data concerning yearly production for both first visits and re-visits for each team. These figures were then used as forecasts, and later used to create production plans. The later was calculated by assuming the same production rate every week of the year. Theses plans were then used to calculate the required doctor capacity and how the matching between doctor capacity, nurse capacity and available examination rooms in the outpatient clinic could be improved. The suggestion that came out of this work was that to level out the work load over the week, and to be able to meet the patients demand, the required capacity regarding doctors was two doctors working in the outpatient clinic every day, from 08.30 am to 03.00 pm, every weekday of the year, including summer and winter holidays. This instead of four to five doctors seeing patients in the clinic a couple of hours before and after lunch, which had been the case before.

Levelling the capacity as suggested and introducing a new schedule for doctors would allow for a higher flexibility concerning extra appointments and acute consultations in the clinic. Today, these are performed at the same time as regular appointments, i.e. between 10.00 am and noon or between 01.00 pm to 03.00 pm, when the staffs sometimes is over-utilised already. Another benefit for the staff in the outpatient clinic would be the possibility to perform other tasks, like answering telephones, attending meetings etc., during the whole day instead of in the hours before and after appointment hours.

The improvement group also treated the issue regarding cancellations with short notice of appointments in the outpatient clinic. This was investigated by extracting data from the information systems and confirming a high percentage of cancellations due to the staff, i.e. the doctors. This problem has been discussed with the doctors and the management has emphasized that cancellations with short notice is unacceptable due to patient satisfaction and to the increased workload for the staff that have to reassign the appointments.

In an attempt to match the available capacity to the predicted patient demand in the clinic for the first five months of 2012, the four team leaders were gathered to a meeting in January 2012, initiated by the project leader and the department manager. At this meeting, each team received weekly production goals, together with calculated doctors capacity required to reach the production goals for the actual period. All figures had been calculated by the improvement group. The team leaders were informed to consider these goals when scheduling the doctors during this period. When the scheduling was done a few weeks later, the team leaders were gathered again together with the manager and the project leader. From the schedules now available, the capacity allocated to the outpatient clinic was calculated and compared to the forecasted demand. Three teams had managed to schedule enough doctors to the meet the forecasted demand, or even schedule more recourses, while one team did not manage to meet the predicted demand due to too few doctors on duty during this period. At this point the team leaders started to discuss their team's possibilities to help the team in need, by re-allocating a number of patients from certain diagnostic groups.

From these meetings it was obvious that the teams want, and need, accurate numbers in order to identify the need of supporting each other in cases of capacity problems. However, it was also clear from the discussions at the meetings that more knowledge and data is required for the future

development. For example, do all the patients in a queue to a specific team need to see a doctor from that specific team, or can other doctors examining them? Another question to be answered is whether the inflow of referrals is stable? If not, why does it vary, and does it affect the production plans to such an extent that the department will have capacity problems?

Due to historical issues regarding scheduling doctors for outpatient appointments, and sometimes also to perform surgery, introducing a minimum number of doctors on duty has been discussed. The department manager and the team leaders, responsible for scheduling the doctors, have agreed to try to allocate at least such a minimum doctor capacity to the different functions within the department, to better meet the demand at all times. This means, for example, restrictions regarding how compensation hours, vacations, etc., can be utilized.

The activities described above can be considered as the first step in developing a better process for production planning and control. In the attempt to involve all doctors at the department, the production results in relation to production plans, queues and waiting times for both the outpatient clinic and the elective surgery have been continuously displayed and discussed at staff meetings during the study. Up until now, very simple charts have been used, but the team leaders and all other personnel are eager to develop this process, as they think it will help them in the effort to reach the production goals.

4.4. Results from the improvement project

The identification of problems, anchored among all personnel categories, and the measures described above can be viewed as the main result of the project and can be categorized in three different topics, i.e. production targets, planning processes and matching production plans and capacity.

The quantitative data below includes all patients referred to the outpatient clinic and all patients that had surgery during the study period, and concerns two important lead times included in the Swedish healthcare guarantee, which both have been in focus in this study. The data. First, the waiting time from the date of referral until the date of the appointment in the outpatient clinic, referred to as “first visit lead time”. Second, the time from the date of decision made to perform surgery until the date the surgical procedure is performed, referred to as “treatment lead time”. As described in section 4.2, these lead times are regulated by law and should be less then 90 days. There are also economic incentives to keep them shorter than 60 days.

The monthly mean values and the standard deviation for first visit lead times are presented in figure 2. The diagram indicates a dramatic change staring in the summer of 2010. This corresponds well to the measures taken at the department as described in section 4.3. Note that dates referred to are the dates of referral and not the date of appointments. During the study period the mean patient lead times decreases and reach a lower level. The peak during the summer is due to decreased capacity during the summer holidays. As shown by the standard deviation in the lower plot of figure 2, the process seems more stable after the measures have been taken.

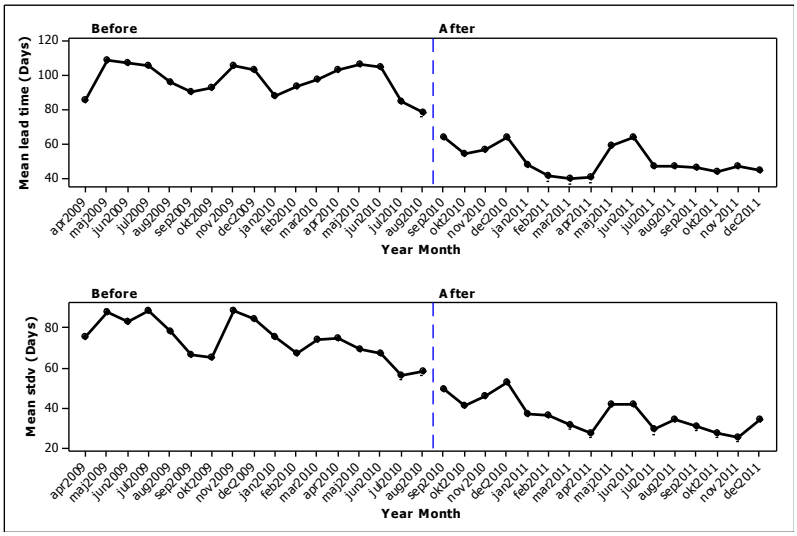

Figure 2: Mean lead time and standard deviation for first visits to the outpatient clinic.

The monthly mean values and the standard deviation of treatment lead times for elective surgery are shown in figure 3. All patients on the waiting lists have been included, regardless if they are ready for surgery or waiting due to special circumstances, i.e. other medical conditions prohibiting surgery, or if the patient wants to postpone surgery to a later date. Also in this case, the standard deviation indicates a decrease in the variation and hence a more stable process. Both figure 2 and 3 shows a continuing decrease in the waiting time throughout the study period.

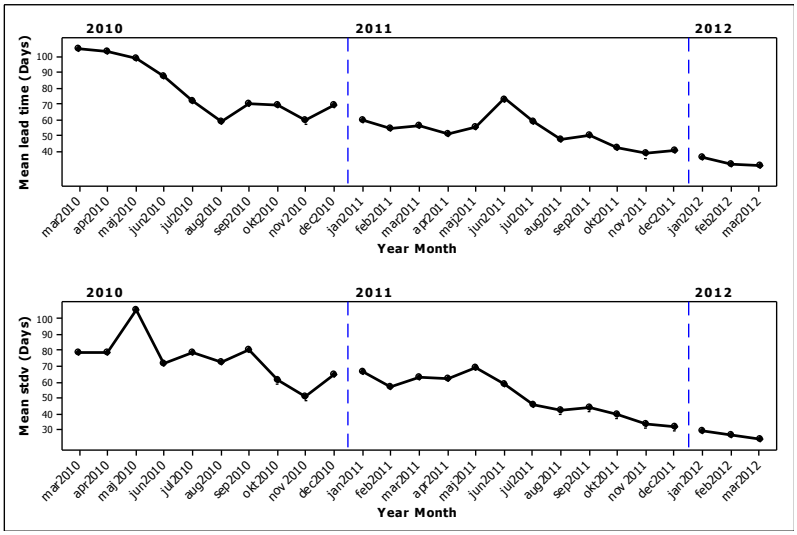

Figure 3: Mean lead time and standard deviation for treatment.

There has been a slight decrease in the number of referrals and in the number of appointments in the clinic, 10% between 2010 and 2011. The total numbers of patients on the waiting lists for appoint-

ments in the outpatient clinic and for a surgical procedure have decreased during the study, but there were no significant change in the total amount of surgical procedures performed on a yearly basis.

As mentioned in section 4.3, the improvement group in the wards and operating theatre implemented a change regarding the admission of all inpatients appointed for elective surgery. The group measured the number of patients admitted to the wards each day during a period of 13 weeks before and a period of 11 weeks after implementing the change. Before the change the daily admission ranged between 0 and 12, after the changed admission routine it ranged from 4 to 6 with, which indicates a levelling of the admission to the wards. Also the perception of the improvement group and the personnel in the wards is that the workload has been levelled, i.e. fewer days with over-utilisation.

5. Discussion

This section presents a discussion of the findings and measures taken within the improvement project, using the models presented in the frame of reference, and aims at relating the improvement measures to the area of production planning and control, trying to identify the causes to problems, and the appropriateness of the implemented changes.

The study set out to better understand the important conditions governing the implementation of PPC systems in healthcare, and to study the benefits possible to gain during a step-wise implementation, starting by implementing rough and simple models. The results from the case shows that great benefits can be achieved, both regarding the awareness of planning problems and necessities in the organisation, and regarding results in terms shortened patient waiting times.

Looking at the measures taken within the project, the main part of them is directed towards the upper levels in the planning model of Jonsson and Mattsson (2009). As stressed by many authors and text-books within PPC, a fundamentally important aspect of a planning system is to align the planning levels to each other. As, for example, the master production scheduling level was virtually missing in the studied case organisation, also a small and rough improvement in this area seems able to make a great difference to the system. The implementation of monthly and weekly production plans within each team, despite not being very advanced, has introduced clear goals to relate to within the teams, and a point of departure in discussion between teams and between the manager of the department and the teams. An important outcome of this was the higher possibility to distribute workload between teams more in accordance with the available capacities compared to required capacities (patient demand).

These results are in accordance with Grimson and Pyke (2007), although that study was only treating the Sales and Operation planning level. They found that measuring of production outcome, etc., together with the business process and the organization (meetings, management, etc.), were strong enablers of well functioning S&OP processes. This was not the case for information technology that showed a much weaker relation.

Levelling of the production plan is probably another explanation to the positive results shown, which is in accordance with principles of lean production (Liker, 2004). In this specific case, one effect of this was a better utilization of both operations rooms and doctors. These resources was better coordinated in the new system, due to rather small changes in policy and in the planning process, involving a review of the doctors' schedules by the operation coordinator. This coordination of resources took very little from a technical point of view, but required management actions. This is accordance with Grimson and Pyke (2007), stating that "leadership" is required to integrate resources and plans.

As noted by van der Krogt et al (2010), effective levelling takes that demand uncertainty can be managed. In this case, practically nothing was done in this respect. Probably, the reason to why this was not necessary is that the independent demand (referrals from primary care) is rather stable. This would also explain why the very rough forecasting method employed was good enough as a starting

point in the development. Preliminary data from the case organization support this statement. However, in order to further develop the processes, mainly at the upper two levels of the planning model, a better forecasting process is important. Experiences from the case organization shows that great disruptions occurs from unexpected – unmanaged would be a better expression – variations in demand. The further development takes that the organization has a continued trust in the development and in the measures taken. Great disruptions due to poor forecasts are a risk in this respect. However, research is scarce on forecasting patient demand at short and medium term horizons at the department level, and healthcare managers and clinicians rely upon rule of thumb methods (Mackay and Lee, 2005). Therefore, this might be an important area for further research.

An effect of the large decrease in waiting times was that the length of queue for many of the diagnosis went too short to be efficiently managed, e.g., the problem being difficulties in allocating patients to available surgery slots in short time. This emphasizes and supports the importance of controlling customer lead-times in make-to-order environments (Hendry and Kingsman, 1993). Possibly, a further developed system in the case organization will employ projected waiting times as the main operational target in the production planning, which at the same time takes that the forecasting process is improved.

A limitation of the study is that the phenomenon in focus, i.e. the changes of the PPC system, is far from isolated in the case. Instead, these changes have been embedded in a more comprehensive change project within the surgery department. In such cases it is difficult judge to which extent the effects studied are due to the studied phenomenon. However, the deep understanding of the case provided by the insider researcher makes the stated findings more valid (Evered and Reis Louis, 1981).

The contribution of this paper is the result that also small and rough implementations of validated production planning and control practices can result in a great improvement of performance in systems being greatly immature in this sense. To practice, this should be encouraging to managers in such organizations. The paper also provides a deep case study description and a deeper understanding of a possible way of running an improvement and implementation project in the area. At a more detailed level, the results of the study support research showing the importance of aligning the different levels of the planning hierarchy, and the importance of controlling customer lead-times in MTO environments. Finally, the study provides an example of the potential efficiency of a levelled production plan.

6. Conclusions

The study reported in this paper dealt with the problems of production planning and control within healthcare, and the immature state of this area within healthcare, having the aim of better understanding the important conditions governing the implementation of PPC systems in healthcare. Of special interest were the benefits possible to gain during a step-wise implementation, starting by implementing rough and simple models. The research approach chosen was a deep case study performed as an action research study, which showed to be effective in the light of the complex system studied, also being confounded with other changes during the study period.

The study concluded that there was a large discrepancy between the mainstream of research in healthcare planning, focusing detailed methods, e.g. within scheduling, and the need of the healthcare organizations. Further, the result of the study clearly indicated that it is possible to gain considerable effects by implementing simple tools and method in the type of system studied. Probably, one reason to the large improvement in terms of patient waiting times was that several measures were directed at the medium-term horizon of the planning system, which from the start of the improvement project was virtually missing. Examples of measures taken were the implementation of well-defined and committed production plans, better levelling of operations, and better coordination of resources.

References

Adan, I., Bekkers, J., Dellaert, N., Jully Jeunet, J. and Vissers, J. (2011), "Improving operational effectiveness of tactical master plans for emergency and elective patients under stochastic demand and capacitated resources, *European Journal of Operational Research*, Vol. 213, No. 1, pp. 290–308.

Belien, J., Demeulemeester, E. (2007), "Building cyclic master surgery schedules with levelled resulting bed occupancy", *European Journal of Operational Research*, Vol. 176, pp. 1185–1204.

Brekke, K.R., Siciliani, L. and Straume, O.R. (2008), "Competition and waiting times in hospital markets", *Journal of Public Economics*, Vol. 92, pp. 1607–1628.

Buchanan, D. and Badham, R. (1999), "Power, Politics, and Organizational Change: Winning the Turf Game", Sage, London

Cardoen, B., Erik Demeulemeester, E. and Jeroen Beliën, J. (2010), "Operating room planning and scheduling: A literature review", *European Journal of Operational Research*, Vol. 201, No. 3, pp. 921–932.

Coghlan, D., Brannick, T. (2005) "Doing action research in your own organization", Sage, London

Derrett, S., Paul, C. and Morris, J.M. (1999), "Waiting for elective surgery: Effects on health-related quality of life", *International Journal for Quality in Health Care*, Vol. 11, No. 1, pp. 47-57.

Evered, R., Reis Louis, M. (1981), "Alternative Perspectives in the Organizational Sciences: "Inquiry from the inside" and "Inquiry from the outside"", *The Academy of Management Review,* Vol.6, No. 3., pp. 385-395.

Grimson, J.A. and Pyke, D.F. (2007), "Sales and operations planning: an exploratory study and framework", *The International Journal of Logistics Management*, Vol. 18, No. 3, pp. 322-346.

Gustavsen, B., (1985), "Workplace Reform and Democratic Dialogue", *Economic and Industrial Democracy,* Vol. 6, No. 4, pp. 461-479.

Hendry, L.C. and Kingsman, B.G. (1993), "Customer Enquiry Management: Part of a Hierarchical System to Control Lead Times in Make-to-Order Companies", *Journal of the Operational Research Society*, Vol. 44, No. 1, pp. 61-70.

Hiidenhovi, H., Nojonen, K. and Laippala, P. (2002), "Measurement of outpatients' views of service quality in a Finnish university hospital", *Journal of Advanced Nursing*, Vol. 38, No. 1, pp. 59–67.

Hoel, M. and Sæther, E.M. (2003), "Public health care with waiting time: the role of supplementary private health care", *Journal of Health Economics*, Vol. 22, pp. 599–616.

Iannone, R., Pepe, C. and Riemma, S. (2011), "A MRP-based architecture to plan resources and to manage waiting queue in hospital systems", *Proceedings of the Second International Conference on Health Informatics*, pp. 478-483, Porto 2009.

Jonsson, P. and Mattsson, S-A. (2009), *Manufacturing Planning and Control*, McGraw Hill Higher Education.

LaGanga, L.R. (2011), "Lean service operations: Reflections and new directions for capacity expansion in outpatient clinics", *Journal of Operations Management*, Vol. 29, pp. 422–433.

Larsson, A. and Johansson, M.I. (2007), "Healthcare planning: A case study of a surgery clinic", PLAN Research and Application Conference 2007, August 2007, Jönköping, Sweden.

Liker, J. (2004), *The Toyota way*, McGraw-Hill, New York.

Mackay, M. and Lee, M. (2005), “Choice of Models for the Analysis and Forecasting of Hospital Beds”, *Health Care Management Science*, Vol. 8, No. 3, pp. 221–230.

May, J.H., Spangler, W.E., Strum, D.P and Vargas, L.G. (2011), ”The Surgical Scheduling Problem”, *Production and Operations Management*, Vol. 20, No, 3, pp. 392–405.

Meropol, N.J., Schrag, D., Smith, T.J., Mulvey, T.M., Langdon Jr, R.M., Blum, D., Ubel, P.A. and Schnipper, L.E. (2009), “American Society of Clinical Oncology Guidance Statement: The Cost of Cancer Care”, *Journal of Clinical Oncology*, Vol. 27, No. 23, pp. 3868-3874.

Nicolay, C. R., Purkayastha, S., Greenhalgh, A., Benn, J., Chaturvedi, S., Phillips, N. and Darzi, A. (2012), “Systematic review of the application of quality improvement methodologies from the manufacturing industry to surgical healthcare”, *British Journal of Surgery*, Vol. 99, No. 3, pp. 324–335.

OECD (2011), “*Health at a Glance 2011: OECD Indicators”*, OECD Publishing. http://dx.doi.org/10.1787/health_glance-2011-en (ISBN 978-92-64-11153-0)

Papadopoulos, T. (2011), “Continuous improvement and dynamic actor associations: A study of lean thinking implementation in the UK National Health Service”, *Leadership in Health Services*, Vol. 24, No. 3, pp. 207 – 227.

Siciliani, L., Stanciole, A. and Jacobs, R. (2009), “Do waiting times reduce hospital costs?”, *Journal of Health Economics,* Vol. 28, pp. 771–780.

SFS, Swedish Statute Book (2010:243), Swedish Health and Medical Services Act (1982:763).

van der Krogt, R., John Geraghty, J., Mustafa Ramzi Salman, M.R. and Little, J. (2010), “On supporting Lean methodologies using constraint-based scheduling”, Journal of Scheduling, Vol. 13, No. 4, pp 301-314.

Vissers, J.M.H., Bertrand, J.W.M. and De Vries G. (2001), “A framework for production control in health care organizations”, *Production Planning & Control*, Vol. 12, No. 6, pp. 591-604.

Vollmann, T., Berry, W.L., Whybark, D.C. and Jacobs, F.R. (2005) *Manufacturing Planning and Control for Supply Chain Management*, 5th edition, McGrall-Hill, Singapore.

Yin, R.K. (2003), *Case Study Research: Design and Methods*, Vol. 5, Sage, Beverley Hills, CA.

Zhang, P., Zhang, X., Brown, J., Vistisen, D., Sicree, R., Shaw, J. and Nichols, G. (2010), “Global healthcare expenditure on diabetes for 2010 and 2030”, *Diabetes Research and Clinical Practice*, Vol. 87, pp. 293-301.